ONELAB: Open Numerical Engineering LABoratory

C. Geuzaine

University of Liège, Belgium

Joint work with R. Sabariego, P. Dular, J.-F. Remacle, E. Marchandise, F. Henrotte

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Some Background...

- We write quite a lot of codes, mostly solvers (GetDP & co)... as most of you do
- Started Gmsh mesh generator & pre-/post-processor in 1996 as a hobby, to “scratch an itch”
- First public binary release in 1998
- GNU GPL release in 2003
- “Getting serious” in 2007: publications, new algorithms, growing community

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Today, Gmsh represents

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- Still only 2 core devs; 75 devs with repo write access
- > 700 people on mailing list
- > 1000 binary downloads per week
- > 200 citations in 2012

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Were are we headed

- Stable C++ and Python API (currently we know of about 15 solvers relying on the undocumented API)
- ONELAB

General Goal of the ONELAB Project

Develop a platform for integrating free Finite Element Analysis (FEA) software

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Two difficulties associated with free FEA software :

- **Heterogeneity of the tools (1)**
- **Missing "expert" layer and documentation (2)**

Existing Projects

The closest (probably): SALOME (http://salome-platform.org)

Main differences design-wise:

- Should be “fast” and “light” -- Emphasis on simplicity
- Provide *abstract* interfaces to CAD, solvers and post-processing
- Optional GUI

Quite close: GiD (http://gid.cimne.upc.es), but not free

ONELAB Guiding Principles

- Don’t reimplement, interface
- Make it easy to provide templates, with interactive parameter modification
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ONELAB role = data centralization, (optional) modification and redispatching

Issues of completeness and consistency of the parameter set are completely dealt with on the solver side

ONELAB Features

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(2) Missing “expert” layer and documentation

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- Model: backbox, parameterizable via abstract interface

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- Model: backbox, parameterizable via abstract interface
- Meta-model: set of models + selection logic

Demo

Demo

Tadaa!

ONELAB Implementation

Client-server:

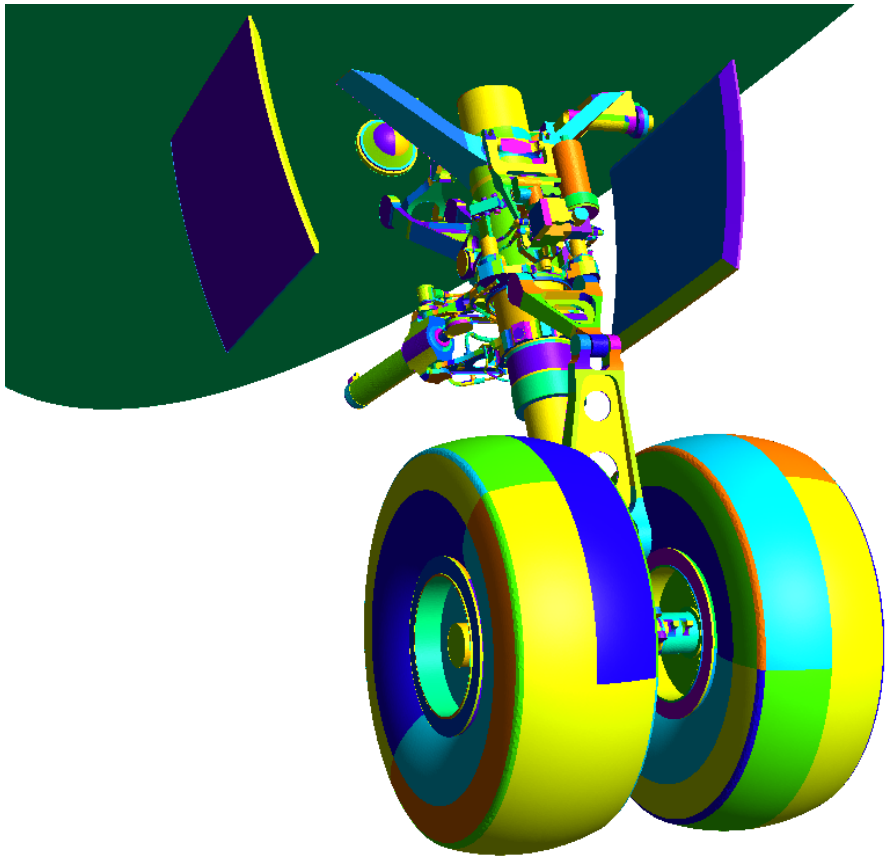
- Clients: CAD kernels, meshers, solvers, post-processors
- Server: Gmsh + database

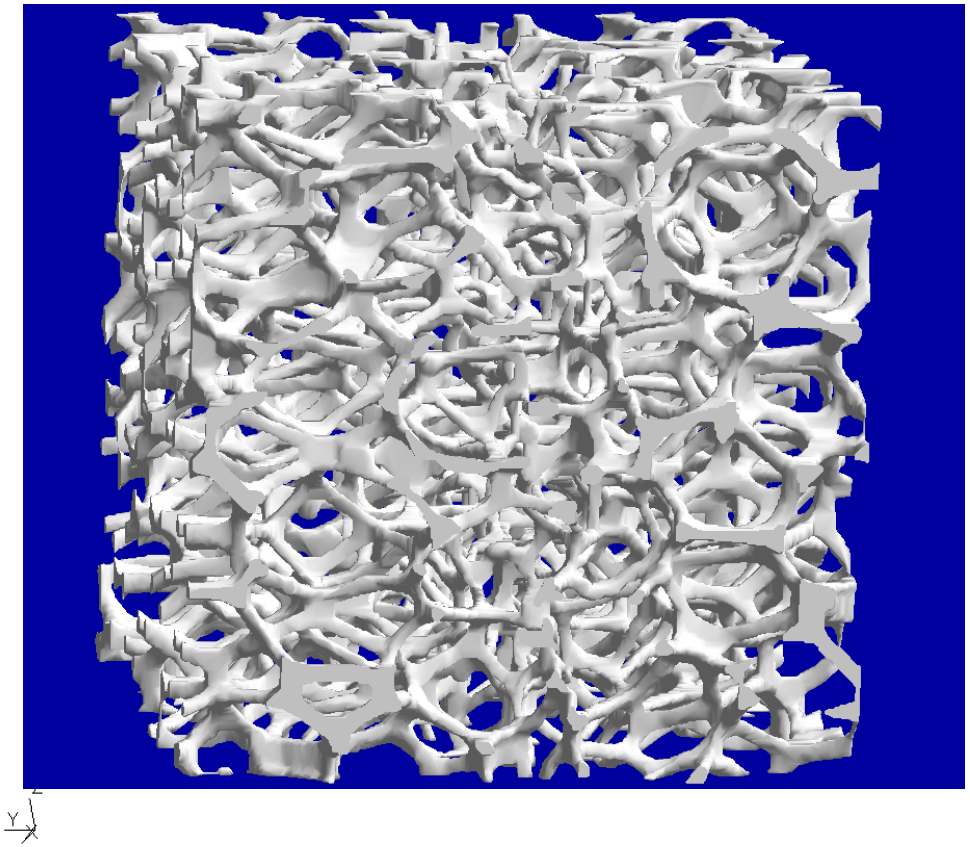
Abstract interface:

- The server **has no a priori knowledge of the clients** (no meta-language or exchange file format)
- The server **does not write input files for (native) clients**: the client communicates with the server to define what information should be exchanged

ONELAB Implementation

Abstract CAD & meshing interface = Gmsh's `GModel` B-Rep model





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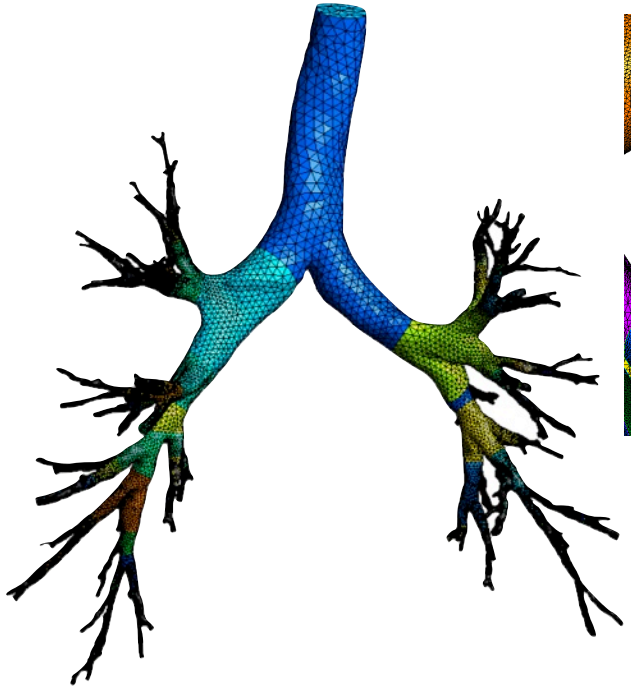
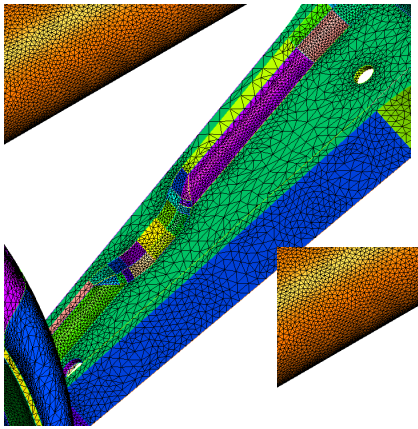
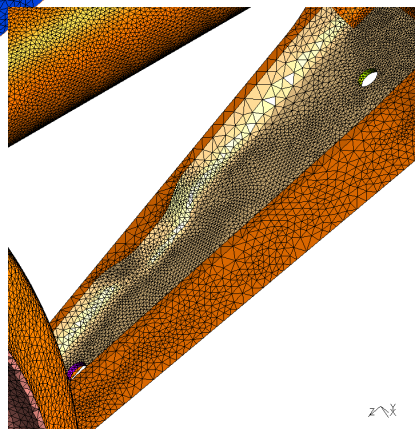
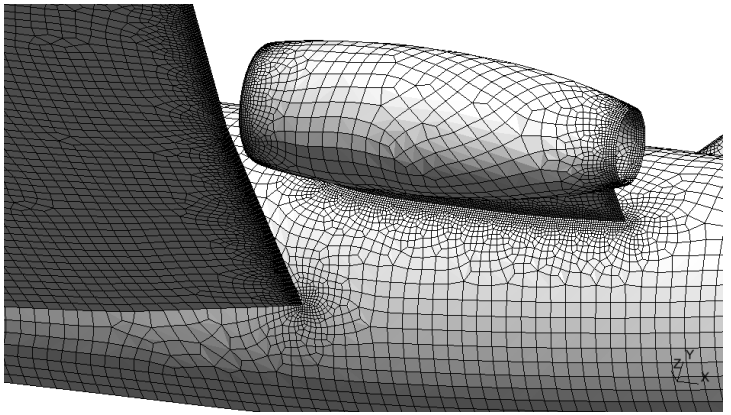
- Direct access to underlying CAD kernels (no translations)
- New features: hybrid models, remeshing, cross-patch meshing, quad meshes, curved meshes









ONELAB Implementation

Abstract interface to physical properties, constraints & code drivers:

- Library for parameter exchange:
  - Server in C++ for portability, e.g. on iOS/Android (`onelab::server`)
  - Client in C++ (`onelab::client`) or Python
  - Exchange parameters (`onelab::parameter`) through TCP/IP or in-memory

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  - Exchange parameters (`onelab::parameter`) through TCP/IP or in-memory
- "Native" clients use C++ (e.g. GetDP in the demo) or Python directly
- "Interfaced" clients use Python, by instrumenting their input files (API available in a couple of month on http://onelab.info)
  - Currently: Elmer, OpenFOAM, Code_Aster, Abaqus, Gnuplot

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`onelab::parameter`

- name as ‘/’-separated path
- dynamic dependency list of clients and status change
- decorations (help, bounds, choices, ...)
- serialization and deserialization

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Example for native Gmsh & GetDP clients (in .geo or .pro files):

```
DefineConstant[ N = {32, Label “Number of slices”} ];
```

Example for Python client:

```
c = onelab.client()
N = c.defineNumber('Number of slices', 32)
```

ONELAB Implementation

Abstract interface to post-processing:

- "Native": based on Gmsh's `PView`, `PViewData`, `PViewOptions`
  - Generic operations on list-based or GModel-based datasets
  - Adaptive visualization of high-order datasets by explicit specification of interpolation matrices

$$P\ (d \times 3) \qquad p_i = \xi^{P_{i1}} \eta^{P_{i2}} \zeta^{P_{i3}}$$

$$\Phi\ (d \times d) \qquad \phi_i = \sum_{k=1}^{d} p_k \Phi_{ik}$$

- "Interfaced": same as interface to other clients

Conclusion

ONELAB is:

- A simple (trivial?) way to interface FEA solvers
- Interactive, based on Gmsh, and free

- You can try it out with native (C++) clients now:
  - Gmsh for CAD/meshing
  - GetDP for electromagnetics and some “multiphysics”
- Generic interface for other solvers using Python will be available soon (later this year)

http://onelab.info